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THESIS

BENCHMARKING AND PERFORMANCE METRICS FOR A DEFENSE DISTRIBUTION DEPOT

by

John C. Anderson
Clifford G. Scott

December 1998

Thesis Advisor: Kevin R. Gue
Associate Advisor: Jane Feitler

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BENCHMARKING AND PERFORMANCE METRICS FOR A DEFENSE DISTRIBUTION DEPOT

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Department of Defense logistics activities are under increasing pressure to reduce their cost of operations. Defense Logistics Agency's response to this challenge is to reduce costs through competition--16 of 22 Defense Distribution Depots will be competed in the near future. Defense Distribution Depot San Diego (DDDC), facing this competition, must assess its relative competitiveness with respect to commercial industry. However, DDDC lacks performance metrics and measurement methods necessary to effectively measure its performance for comparison. The purpose of our thesis is threefold: to identify performance measures, measurement methods, and uses of performance measures by leaders in the physical distribution industry; to determine the depot's competitive position by quantifying the gap in performance using the performance metrics identified; and to identify the qualitative factors contributing to the gap in performance between the depot and commercial firms. We employ benchmarking methodology to argue that there is a significant gap in performance between DDDC and commercial distribution firms. We quantify the gap and discuss the qualitative factors contributing to it. We conclude with recommended productivity performance indicators for implementation at DDDC.

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I. DLA AND COMPETITION

A. ENVIRONMENT

The Defense Logistics Agency (DLA) provides worldwide logistics support to the armed services through two primary means: acquisition and material management. DLA is the Department of Defense's (DOD) primary logistics provider, managing 89% of the items used by the services. It maintains an inventory valued at $9 billion to support 32,000 customers making 22 million requests per year. [Ref. 1:p. 1]

DOD logistics activities are under increasing pressure to reduce costs. DOD has demanded $500 million in savings and a 40% reduction in infrastructure within DLA by fiscal year 2005. The means most often prescribed to achieve significant cost savings are through adopting industry best practices, competition, and outsourcing. DLA has responded by initiating Commercial Activity Cost Competition (A-76) for 16 of its 22 Defense Distribution Depots. [Ref. 2:p. 12] A-76 is a process in which distribution depots compete against commercial firms to provide physical distribution services to DLA customers. DLA estimates that A-76 will achieve annual savings of 20 percent by reducing operating and overhead costs, either with a commercial contractor or with an improved government-run operation. [Ref. 2:p. 12]

To prepare for competition, Defense Distribution Depots must examine their operations and develop their *Most Efficient Organization* (MEO). An MEO is a depot's plan to meet mission requirements with the fewest possible resources, thus becoming the government's bid in the A-76 competition. The depot's MEO must reflect operating and

overhead costs competitive with comparable commercial firms to have any chance of success. Depots must compare their performance to industry's to determine their relative competitive positions.

Our research focuses on Defense Distribution Depot San Diego (DDDC), which soon must submit a competitive bid for A-76 competition. To be competitive, DDDC must determine:

- Their current level of performance in core warehousing processes;
- The level of performance achieved in competitive industry;
- The gap between their performance and competitive industry; and
- The underlying causes leading to the gap.

DDDC currently has few performance metrics and associated standards in place, making it difficult to evaluate the depot's performance relative to commercial firms. To enable DDDC to develop a competitive and justifiable MEO, we use benchmarking methodology to:

- Identify performance measures, measurement methods, and uses of performance measures by leaders in the physical distribution industry.
- Determine the depot's competitive position by quantifying the gap in performance using the performance metrics identified.
- Identify the qualitative factors contributing to the gap in performance between the depot and commercial firms.

B. BACKGROUND

Both the DLA Strategic Plan and Defense Logistics Support Center (DLSC) Long-Range Business Plan have an objective to "implement a comprehensive 'streamlining through competition' strategy" by FY 1999 [Ref.3: pp.5-10]. The strategy was implemented 31 March 1998 when DLA announced that it would conduct the first three A-76 competitions for its depots in Columbus, Ohio; Warner-Robbins, Georgia; and Barstow, California.

DLA plans to subject 16 of 22 depots (see Figure 1.1) to competition over a five-year period with completion by April 2003. Of the remaining six depots, sites in San Joaquin, California and Susquehanna, Pennsylvania, will not be subject to competition because they are DLA's primary distribution sites. Defense Distribution Depot Europe is not slated for competition as well. The three remaining depots (Letterkenny, Pennsylvania; McClellan, California; and San Antonio, Texas) were identified for elimination under the Base Realignment and Closure process. [Ref. 3:pp. 14-19]

1. OMB Circular A-76

The Office of Management and Budget (OMB) Circular A-76, first published in 1951, governs the competition process. OMB Circular A-76, "Performance of Commercial Activities", established Federal policy for the performance of recurring commercial activities. A commercial activity is "the process resulting in a product or service that is or could be obtained from a private sector source." [Ref. 4:p.35] Janitorial services, maintenance services, and groundskeeping are examples of such commercial

activities. The emergence of third party logistics providers in the commercial sector has given rise to the use of OMB Circular A-76 to defense depot operations.

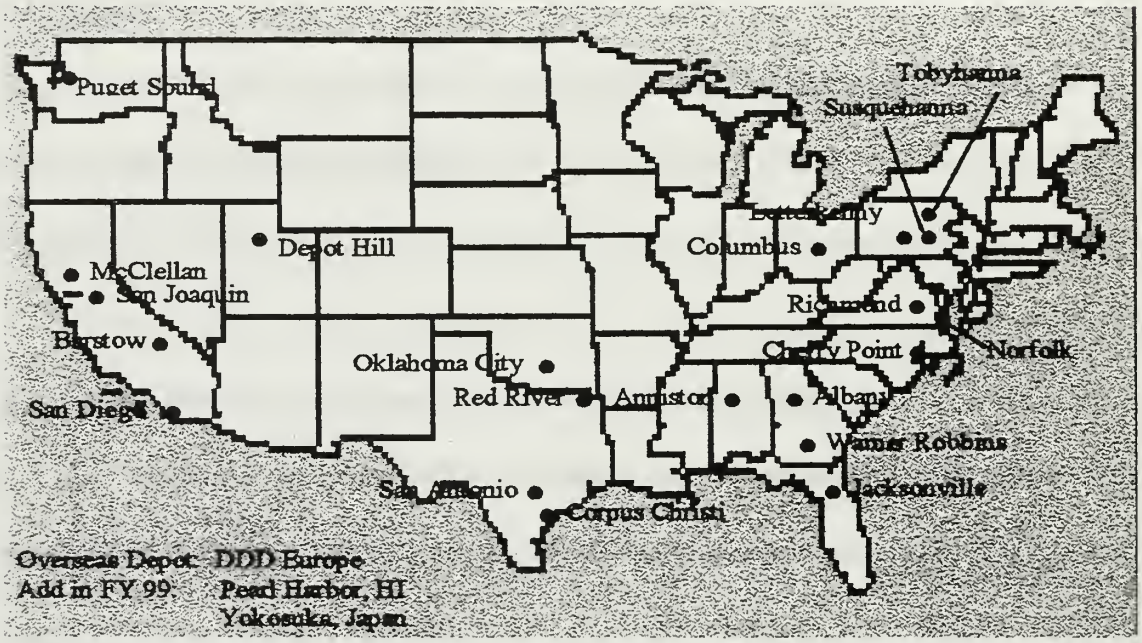

Figure 1.1. Defense Distribution Depots

OMB Circular A-76 is not designed to simply contract out government functions; rather, it is designed to: (1) balance the interests of the parties on a make or buy cost comparison, (2) provide a level playing field between public and private offerors in a competition, and (3) encourage competition and choice in the management and performance of commercial activities [Ref. 4:p. iii].

2. DLA Plan for Executing A-76 Process

DLA plans to execute the A-76 process in a number of rounds. Depots are chosen based upon their stability, complexity, customer considerations and projected savings.

Each depot will establish a team to coordinate the A-76 process. The team begins by gathering data and interviewing the depot workforce in order to define mission requirements. The defined mission requirements become the Performance Work Statement (PWS). The government issues a Request for Proposal (RFP), soliciting bids from the private sector to execute the work in the PWS. While the government is soliciting commercial vendors, the depot's team develops the MEO required to accomplish the work in the PWS; the MEO becomes the government's bid in the competition. Depots and commercial vendors have 18 months to concurrently develop their bids. [Ref. 5:p. 1]

An Evaluation Board reviews contractor bids by determining which contractor best meets the evaluation factors established in the RFP. The contractor's and government's bids are compared, and the contract is awarded to the lowest bidder, with one prerequisite. The contractor's bid must better the government's bid by at least 10% of the personnel costs in order for the contract to be awarded to the commercial firm. [Ref. 5:p. 1]

C. ORGANIZATION

In the next chapter, we discuss performance measurement and our benchmarking methodology. Chapter III discusses the performance measures used by DDDC and benchmark firms, the methods by which the measures are obtained, and how the measures are used in management. Chapter IV quantifies the performance gap and

discusses the qualitative factors contributing to the gap. Chapter V provides conclusions and recommendations.

II. METHODOLOGY

We employed benchmarking to determine the level of performance DDDC must achieve to be competitive in A-76 competition. There are strong incentives for undertaking the benchmarking process. Done correctly, the organization increases its understanding of strengths, weaknesses and the performance levels required to stay competitive. Benchmarking provides an effective tool to discover emerging technologies and processes within an industry, and facilitates the identification of new methods of doing things and challenging the status quo. To use a popular expression, benchmarking breaks down the "not-invented-here" syndrome. [Ref. 6:p. 34]

Benchmarking is also recognized for its ability to accelerate the rate and degree to which organizations improve their operations, because leaders are more likely to implement a major change in work processes when they are convinced that it has been done successfully by others. [Ref. 7:p. 11]

A. PROCESSES INVOLVED

DDDC provides supply and physical distribution support to 89 ships, 86 major shore commands, and other smaller activities in the San Diego area. In addition, DDDC ships material worldwide to deployed and overseas activities. DDDC maintains two storage compounds, one at Naval Air Station North Island and a second at Naval Station San Diego. The two facilities include 27 warehouses with 10 million cubic feet of storage, 512,000 square feet of open storage, and 430 personnel. [Ref. 8:pp.1-2]

DDDC carries an inventory of 460,000 line items with approximately 280,000 on-hand at any one time. DDDC employs a combination of both mechanized and non-mechanized storage and retrieval systems to process approximately 30,000 receipts and 70,000 issues per month. [Ref. 9:pp. 3-7] A description of the storage and retrieval systems utilized by DDDC is included in Appendix A.

DDDC is experiencing a decline in workload because a declining DOD customer base demands less material and consequently there are fewer receipts and issues per year. Total receipts and issues have declined 3%, 15%, and 20% in Fiscal Years 1996, 1997, and 1998 respectively (see Figure 2.1).

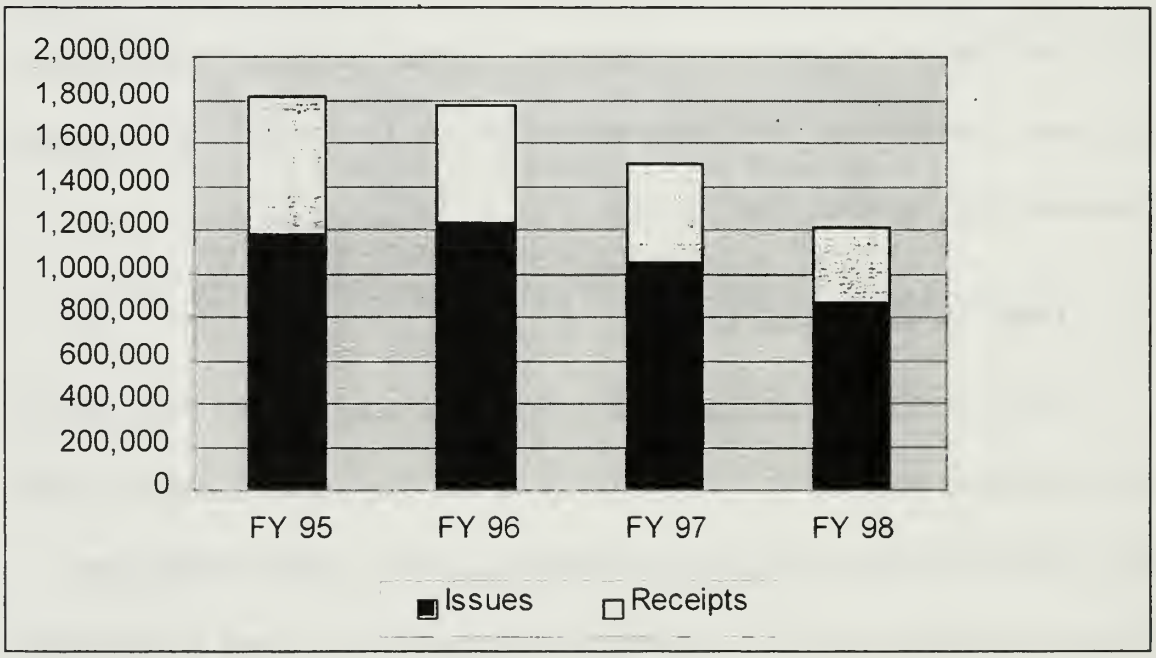

Figure 2.1. Receipts and Issues (Workload) at DDDC

1. Defense Distribution Depot San Diego Organization

DDDC is organized into two functional departments: depot support and production. DDDC's organization chart is provided as Figure 2.2. The depot support department is dedicated to supporting the core functions of DDDC. It is on the core functions of the depot, performed by the production department, that we focus our benchmarking efforts.

2. Defense Distribution Depot San Diego Core Functions

The production department performs the core functions of the depot: receiving, storing, picking, packing, sorting, staging, and shipping material to customers. The production department is the larger of the two departments and has 340 personnel working throughout 27 warehouses. Production employees handle a wide variety of material and use both mechanized and non-mechanized storage methods. We concentrate our benchmark efforts on the core functions of the depot.

The Production Department is comprised of three divisions: Storage, Pack and Ship, and the North Island division. We examined the functions of each division to gain an understanding and for later comparison to potential benchmarking candidates.

a. Storage

The storage division comprises the receiving, mechanized and non-mechanized storage and retrieval, and night processing divisions. These divisions work only at Naval Station facilities. Personnel receive truckload, less than truckload, and

express (FEDEX, UPS, etc.) shipments of material from suppliers. Personnel segregate and then induct material according to its ultimate disposition as shown in Figure 2.3.

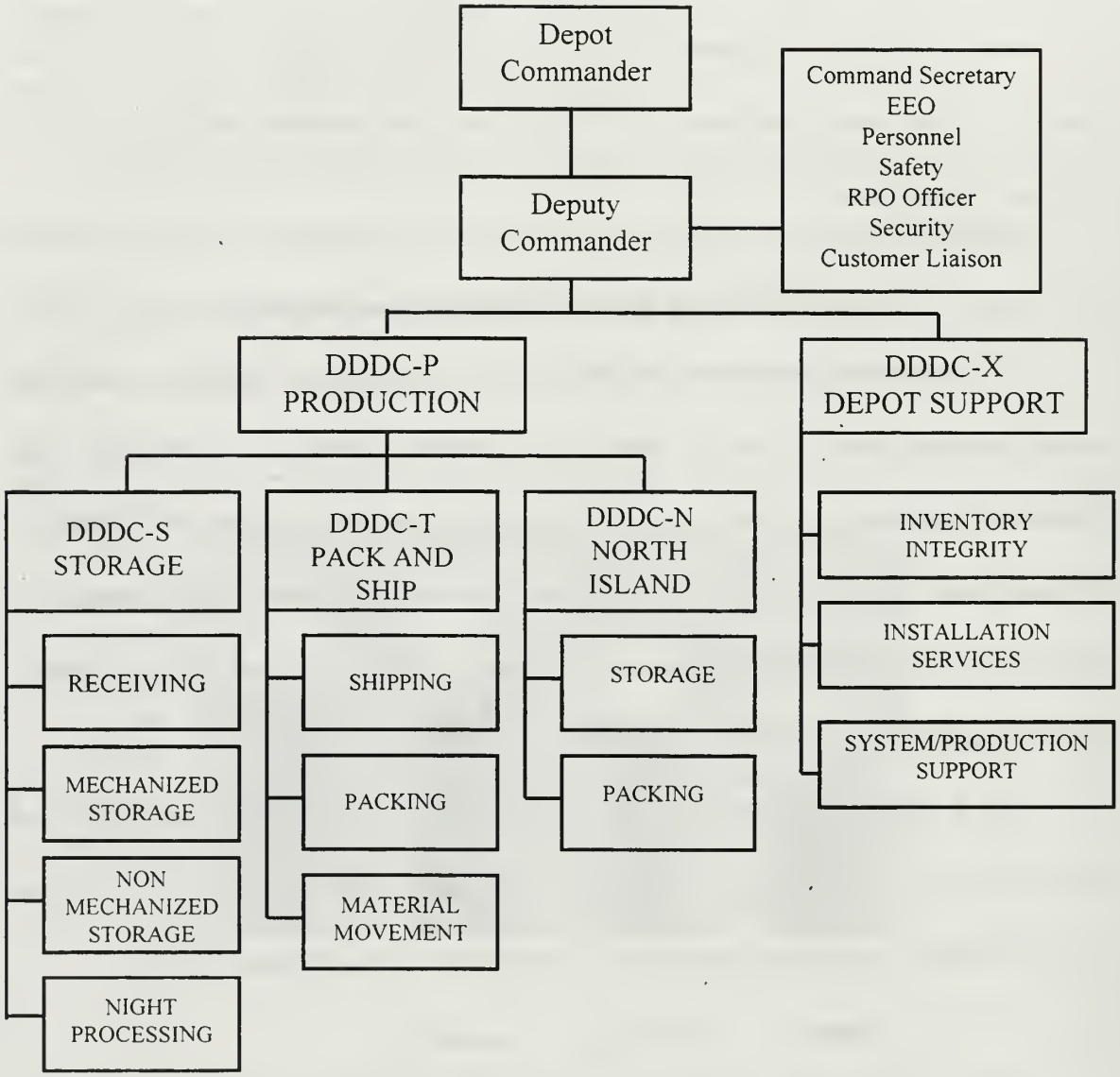

Figure 2.2. DDDC Organization Chart

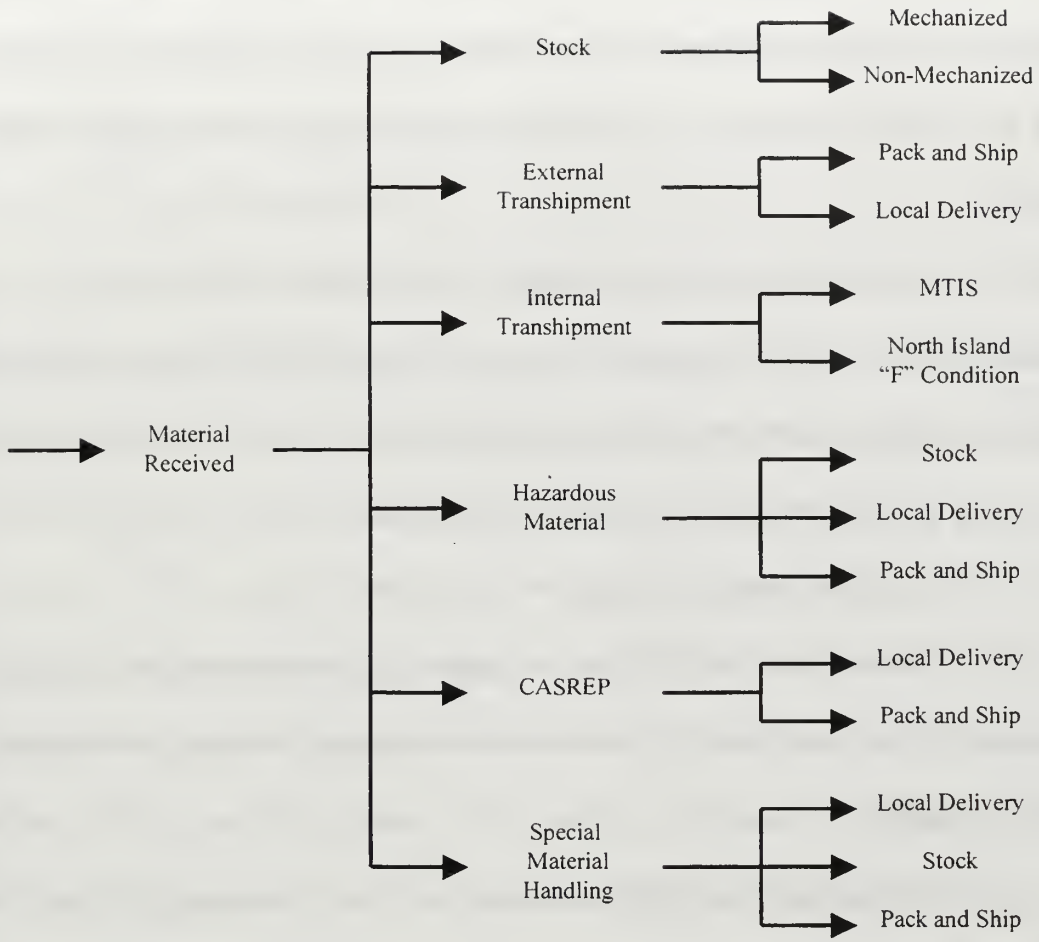

Figure 2.3. Material Categories and Disposition

Mechanized storage personnel stow receipts and pick material from locations in the mechanized warehouse (see Appendix A) to fill customer orders. The mechanized division is responsible for light packing of material picked from mechanized storage locations and for sorting and staging material for local delivery. Miscellaneous functions include rewarehousing, inventory audits, and housekeeping.

Non-mechanized storage personnel receive and pick those items that are not assigned a mechanized storage location. These items are handled by forklift truck, stowed and picked from bins, boxes, or full pallets, and stored in several different warehouses.

The Night Processing division is the second shift operation for the mechanized storage division. Night processing conducts all functions of the mechanized division during the second shift and other requirements as necessary. An example is the processing of walk-thru requests after normal working hours.

b. Pack and Ship Division

The pack and ship division is comprised of three workcenters dedicated to packing material; shipping by commercial carrier to customers; and local movement and delivery of material.

Packing personnel prepare medium and heavy packaging for depot and customer material (i.e., packing material within cardboard boxes or building special crating for material requiring shipment). Shipping personnel assign a carrier based upon the material's ultimate destination. Shipping then prepares Government Bills of Lading, truck manifests, and premium transportation documentation. Shipping physically verifies material against prepared manifests prior to closeout and installs tamper-proof seals on shipments.

Material movement is responsible for loading and transporting customer material within the immediate geographical area. Material movement is also responsible for movement of material between DDDC facilities.

c. North Island

The North Island division performs all of the core warehousing functions using non-mechanized facilities. Their primary customer is the Naval Aviation Depot North Island (NADEP N.I.) which repairs aviation depot level repairables (AVDLRs). Two workcenters comprise the North Island Division; Storage and Packing.

The storage workcenter receives and stores "F" (failed) condition AVDLRs awaiting induction for repair at NADEP N.I. After the AVDLRs have completed the repair cycle, they are returned in "A" (ready for issue) condition for storage awaiting customer requests. The packing workcenter maintains two separate packing operations. One packs "A" condition DLRs for shipment to customers. The other processes "A" condition material returns from NADEP N.I. and packages for storage at North Island Division.

B. BENCHMARK FIRMS

World class physical distribution facilities distinguish themselves from their competitors with state-of-the-art processes and facilities, resulting in industry-leading performance. Frazelle [Ref. 10:p. 109] has developed a warehouse practices analysis and scoring system to determine the performance of physical distribution firms relative to world class practices. The criteria are shown in Figure 2.4.

Functional Area	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Rating
Receiving	Unload, Stage, & Check In	Immediate Putaway to Reserve	Immediate Putaway to Primary	Cross-Docking	Pre-Receiving	
Putaway	First-Come-First-Served	Batched by Zone	Batched and Sequenced	Location to Stocker	Automated Putaway	
Storage	Floor Storage	Conventional Racks & Bins	Some Double Deep Storage	Some Narrow Aisle Storage	Optimal Hybrid Storage	
Picking	Pick to Single Order	Batch Picking	Zone Picking with Progressive Assembly	Zone Picking with Downstream Sorting	Dynamic Picking	
Slotting	Random	Popularity Based	Popularity and Cube Based	Popularity, Cube, and Correlation Based	Dynamic Slotting	
Replenishment	As Needed-Pick Face Complete	As Needed Downstream Complete	Anticipated by Sight	Anticipated-Automated	Pick from Reserve Storage	
Shipping	Check, Stage, & Load	Stage & Load	Direct Load	Automated Loading	Pick-to-Trailer	
Work Measurement	No Standards	Standards Used for Planning	Standards Used for Evaluation	Standards Used for Incentive Pay	Standards Used for Continuous Feedback	
Communications	Paper	Bar Coding and Scanning	RF Terminals	Hands Free	Virtual Displays	

Figure 2.4. Warehouse Practices Analysis and Scoring

We sought to identify world class organizations having missions and functions comparable in nature to DDDC. Our emphasis was on companies that employ performance metrics to evaluate productivity within their organizations. We determined benchmarking firms a using three-step process: The first step was to identify a pool of physical distribution facilities that are considered world class. The second step was identifying those within the pool that have a mission and scope of business comparable to DDDC and were willing to participate in our study. The third and final step was to identify those that were the most comparable. Our goal was to select companies using industry best practices and providing the best overall "fit" with DDDC.

1. World Class Physical Distribution Facilities

We identified 12 physical distribution facilities through sources including trade and industry publications, industry experts, university sources, and consulting firms. From these sources, we identified the following benchmarking candidates:

- Boeing
- Napa Auto Parts
- Menlo Logistics
- L.L. Bean
- Caterpillar
- W.W. Grainger
- Ryder Logistics
- AAFES
- John Deere
- Land's End
- FEDEX
- Orchard Supply Hardware

At the request of benchmarking participants, we do not attribute figures or performance data to firms within this thesis. Companies will be identified by letter designation.

2. Mission and Scope Comparable to DDDC

From the list of potential benchmarking partners we eliminated a number of firms either because of their unwillingness to participate, their limited comparability in scope of operations, or the time and travel distance constraints of the authors. We present the remaining firms in Figure 2.5, with the 11 salient criteria we developed to determine comparability with DDDC.

3. Choosing Benchmarking Partners

From these firms, we sought to narrow the field of benchmarking partners to three that are most comparable to DDDC. Site visits and interviews were used to gather data relating to the 11 criteria in Figure 2.5. Company F was eliminated because it had ineffective metrics and therefore contributed little to our study. Companies B, D, and G were eliminated because of the dissimilarity of their core processes. Companies A, C, and E were then chosen as benchmarks.

Companies A, C, and E distribute items worldwide and carry a comparable number of line items (310,000 to 400,000), within a reasonable range of DDDC (460,000). Companies A, C, and E operate large facilities, and their storage and retrieval systems encompass non-mechanized, mechanized, and mixed storage facilities. The range of storage and retrieval systems allowed us to observe and benchmark the same basic processes using a variety of methods.

A critical determinate was the benchmark firm's use of metrics. Companies A, C, and E employed metrics effectively throughout their processes. They use technology

similar to that used by DDDC (i.e., handheld RF terminals and extensive bar-coding). DDDC's workforce is unionized, as are companies A, C, and E. Companies A, C, and E were also open and willing to share data with us.

Comparability of core processes was critical to the determination of firms to benchmark. Companies A, C, and E use processes that are either similar to, or improvements upon similar processes used at DDDC.

Although we eliminated a number of firms as primary benchmarks, they still had much to offer our study. Some had exceptional use of metrics, but were measuring dissimilar processes. Others had innovative incentive programs that may serve as models for use by DDDC. It is important to remember that in functional benchmarking, companies utilizing dissimilar processes may have something to offer. As Camp states:

> Ultimately what is desired is the best of the practices because only the innovative application of those practices will lead to superior performance. They (the benchmarking firm) must be able to see the possibilities of the assembly of the best of best practices from several sources and from dissimilar operations. An inquisitive, positive interest in uncovering and innovatively applying best practices is a necessary trait for functional industry benchmarking. [Ref. 6:pp. 64-65]

If we apply Frazelle's warehouse practices analysis, none of the firms above would be considered world class in all functions. Industry experts agree that no one firm uses world class practices for every function they perform. The firms we have identified above use middle to world class practices. We will refer to chosen benchmark firms as world class for convenience and quantify their standing with Frazelle's methodology in Appendix B.

Criteria	Company							
	DDDC	A	B	C	D	E	F	G
Distribution Network	Worldwide	Worldwide	Regional	Worldwide	National	Worldwide	Worldwide	Regional
Issue Priorities	4	2	3	2	2	5	1	1
Line Items Carried	480K	325K	110K	310K	60K	400K	16K	25K
Facility Size	28M cu. ft.	1.8M sq. ft.	100K sq. ft.	2.2M sq. ft.	110K sq. ft.	700K sq. ft.	1.4M sq. ft.	456K sq. ft.
Degree of Mechanization	Mixed	Non-mech	Non-mech	Mechanized	Non-mech	Mixed	Non-mech	Non-mech
Employment of Metrics	Ineffective	Effective	Effective	Effective	Effective	Effective	Ineffective	Effective
Technology Employed	Bar-coding Handheld RF	Bar-coding Handheld RF	Order Pick List	Bar-coding Handheld RF	Order Pick List	Bar-coding Handheld RF	Bar-coding Handheld RF	Bar-coding Handheld RF
Customer Order Volume	3,461/day	33,741/day	17,000/day	50,500/day	4,300/day	5,000/day	32,500/day	47,000/day
Union Representation	Yes	Yes	No	Yes	No	Yes	Yes	No
Number of Employees	339	240	56	744	56	170	564	210
Willingness to Share Data	Open	Open	Open	Open	Open	Open	Open	Open
Comparability of Core Processes:								
Receipt		Dissimilar	Similar	Dissimilar	Similar	Highly Similar	Similar	Dissimilar
Stow		Similar Non-mechanized	Dissimilar	Similar Mechanized	Dissimilar	Highly Similar	Similar Non-mechanized	Dissimilar
Pick		Similar Non-mechanized	Dissimilar	Dissimilar	Dissimilar	Highly Similar	Similar Non-mechanized	Similar Non-mechanized
Sort and Stage		Not Applicable	Similar Non-mechanized	Similar Non-mechanized	Dissimilar	Highly Similar	Similar Non-mechanized	Dissimilar
Pack and Ship		Dissimilar	Dissimilar	Highly Similar	Dissimilar	Highly Similar	Dissimilar	Dissimilar
Material Range		Highly Similar	Dissimilar	Highly Similar	Similar	Highly Similar	Similar	Similar

Figure 2.5. Benchmark Participants

III. MEASURES, METHODS, AND MANAGEMENT

A. PERFORMANCE INDICATORS

Site visits and interviews with employees at benchmark firms and DDDC focused on answering three questions: what is being measured, how the measurement is obtained, and how the measurement data is being used in the management of the core functions? We categorized performance measures as falling into one of three areas: general business, productivity, and customer service.

- General business performance indicators measure the overall value of the physical distribution function to the company. These indicators relate the distribution function to profit in terms of dollar contribution or cost and capture aspects of the effectiveness of inventory management.
- Productivity performance indicators measure the ratio of outputs to inputs in the physical distribution function. In the warehouse, productivity typically refers to labor productivity – the number of units (pounds, lines, orders, cases, pallets, etc.) handled divided by the number of person hours involved.
- Customer service performance indicators measure external and internal customer service expectations. External customer service expectations are those that are most visible to the customer and include providing the right item(s), the right quantity, at the right time and in the right condition. Internal customer service expectations are those that are less visible to the customer, but are utilized by management to gauge the effectiveness of internal processes that will directly affect service to the external customer. [Ref. 6:p. 127]

B. WHAT IS BEING MEASURED

1. Business Performance Indicators

DDDC uses two business performance indicators, Lines to Full Time Equivalents (FTE) and Cost Per Line. A line represents one material receipt, issue, or disposal. For

example, a receipt of 20 cases of identical stock numbered filters is counted as one line. FTE is the total number of hours worked by employees (less overtime) divided by 2080 hours (number of hours one employee is available for work in one year (52 weeks X 40 hours per week)). DDDC direct and indirect costs are divided by the total number of lines processed for a reporting period. The reporting period is usually per month and summarized on a yearly basis.

There was little variation among benchmark firms in what was measured; though the measurement terms used sometimes differed. Benchmark firms measured Inventory Turnover, Sales to Inventory Ratio, Administrative Support Costs as a Percentage of Sales, and Sales to FTE.

DDDC's business performance indicators are somewhat unique to the DOD business environment. DDDC does not own the material it distributes and does not make decisions regarding what items are carried. An Inventory Turnover and Sales to Inventory Ratio is not useful to DDDC if they have no control over inventory positioning or depth. Sales to physical distribution cost or sales per employee are not calculated for similar reasons. DDDC's Cost per Line is a reasonable approximation of benchmark firm's Physical Distribution Costs as a Percent of Sales. Similarly, DDDC's Lines to FTE is closely aligned to benchmark firm's Sales to FTE.

2. Productivity Performance Indicators

There is only one productivity performance indicator actively measured by DDDC. The Packing division gathers data by employee on the type and number of packs

per day. This data is summarized to calculate the number of packs per hour per employee, by pack type. Performance standards for the number of packs per hour per employee, by pack type, are incorporated in the individual performance plans for personnel assigned to the Packing division.

Packing division performance standards were developed from historical measured performance. This data was used to establish a range of performance from Fully Successful down to Minimally Successful. Performance below Minimally Successful is considered unsatisfactory. Employee data is gathered through the use of simple check sheets. Employees record the type and number of packs throughout the workday, and supervisors tabulate the employee's check sheets to calculate their productivity.

The Labor and Personnel Reporting System (LAPERS) is designed to report divisional labor efficiency at all 22 distribution depots. Divisional labor efficiency is calculated by identifying the actual production volume for one of 80 DDDC functions and the corresponding actual hours charged to perform that function. A functional standard is then applied to the actual production volume to determine the number of standard hours that should have been charged to perform that volume of work. The ratio of standard hours divided by actual hours is the calculated labor efficiency. An example of the LAPERS report is provided as Figure 3.1. There are more than 80 functional standards within the core production processes at DDDC. The standards were derived from Defense Integrated Management Engineering System (DIMES) time and motion studies of core warehousing elements.

Industrial engineering analysts from DDC-West visited DDDC for a five-week period in late 1996 to calculate functional standards reflecting current operating procedures. Distance and travel times from computer terminals, receiving docks, storage locations and sort and pack areas were determined to calculate exacting time requirements for each function. [Ref. 11] Frequency of required travel, environmental factors (noise, lighting) and fatigue/delay are built into the standard equation. This process is highly detailed and paperwork intensive.

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ACTIVITY ABBREVIATION DDDC WORK CENTER LEVEL (FINAL) REPORT DATE 30 SEP 98

ORGANIZATION N NORTH ISLAND DIVISION

SUBSIDIARY COST CODE AND TITLE / UNIT OF MEASURE TITLE	PERFORMANCE NO	STD	WORKLOAD REC	PROC	BALANCE ON HAND UNITS	HOURS	ACTUAL HOURS	STANDARD HOURS	PCT EFF	EQUIV-PERS ACTUAL	STD	O/H	M-D
321011018 BIN RCPT													
M BIN RCPT STOW-UC	3330	.1433	4708	4708			259.50	674.66	260.0	1.5	4.0		
322011018 MED BULK RCPT													
M MED BULK RCPT STOW-UC	3251	.1336	14298	14298			1112.50	1910.21	171.7	6.6	11.4		
322031018 HVY BULK RCPT													
M HVY BULK RCPT STOW-UC	3252	.1355	647	647			452.50	87.67	19.4	2.7	.5		
331011008 BIN ISU													
BIN L/I PACK	4310	.1955	2699	2699			133.00	284.74	214.1	.8	1.7		
331011018 BIN ISSUE													
M BIN L/I ISSUE	3335	.0605	2940	2940			267.00	177.87	66.6	1.6	1.1		
33													
M								901.64					
33													
M	3320							499.42					
332013000 PACKAGING SUPPORT	0000	0001						02					
332013050 BULK PACK SUPERVISION	0000	1.0000								.5	1.0		
332041008 PACK HEAVY BULK MAT'L													
M PACK HEAVY L/I	4316	.5629	1007	1007						6.7	3.4		
332041018 HVY BULK ISU													
M HVY BULK ISU-UC	3321	.1768	1126	1126						.6	1.2		
341013050 TRANSPORTATION SUPERV	0000	1.0000					123.00	123.00	100.0	.7	.7		
353011018 REWHSE MIXED COMMODIT													
REWHSE BIN L/I	4531	.1616	177	177				28.60			2		
REWHSE MED BULK L/I	4536	.3168	2623	2623				830.97			4.9		
REWHSE HEAVY L/I	4538	.5962	2322	2322				1384.38			8.2		
**********	9998						375.00	2243.95	598.4	2.2	13.4		
358013000 WHSE OPS SPT	0000	.0001					120.00	102.48-		.7	.6-		
358013050 SUPERVISION	0000	2.0000					109.00	277.00	254.1	.6	1.6		
358013098 CLERICAL SUPPORT	0000	2.0000					16.00	320.00	999.9	1	1.9		

Cost Code, Function performed, and i.d. number of function.

Standard time to complete function in

Work quantity received and processed within function for month of Sep. 1998.

Actual hours assigned by function supervisor to complete work

Percent Effective or Labor Productivity Rate.

177.87/267.00 = 66.6%

Standard hours to complete work quantity received and processed.

.0605 X 2940 = 177.87

Figure 3.1. Sample Page from LAPERS Report

Considerable time and effort were expended to calculate functional standards at DDDC, considering each standard may be as long as 100 pages and there are more than 80 standards in place. It is important to realize that these time and motion studies calculated the standard time required to perform each function in the process, while making no evaluation of the need for the function or the process utilized. There was no consideration as to whether the process represented the best practice; it was merely the process that was in place at the time of the study. DDDC is free to change the process at any time it desires, and it frequently does change processes in its efforts to achieve greater efficiency. DDDC's recently converted to a new warehouse management system (WMS), the Distribution Standard System (DSS), which is used throughout DLA distribution depots. The conversion, and a reorganization of the production department, occurred after functional standards had been calculated. The significant changes in warehouse processes resulting from the reorganization and DSS implementation invalidated many of the functional standards LAPERS uses to calculate labor efficiency. The invalid functional standards result in labor efficiency measurements that are of little use to DDDC managers.

An important issue in measuring productivity is determining an appropriate measure for labor. For example, labor hours could include operators, supervisors of operators, managers of supervisors, and maintenance and housekeeping personnel. It is important to ensure that when comparing DDDC to benchmarked firms the labor included is comparable. We observed that customer service, inventory administration, sales and

marketing, and systems analysis positions were generally excluded in productivity calculations among benchmark firms.

Benchmark firms measured productivity in each of the core functions to the hour (i.e., line items per hour per person). We observed the following performance indicators:

- Lines Received Per Hour Per Person,
- Lines Stowed Per Hour Per Person,
- Lines Picked Per Hour Per Person,
- Number of Packs Per Hour Per Person,
- Number of Shipment Manifests Per Day Per Person,
- Annual Lines Shipped to Annual Labor Hours Expended, and
- Annual Lines Inventoried to Dedicated Inventory Labor Hours Expended.

3. Customer Service Performance Indicators

DDDC's measurement efforts are focused on customer service performance indicators. Standards for customer service are set by DDC with the intent to provide a level of service equivalent to what they believe is being achieved in world class firms. The following DDC standards apply:

- Material received from suppliers must be stowed and available for issue within one day.
- Material returned must be stowed and available for issue within one day.
- Customer orders, regardless of priority, must be processed within one day.
- Material designated for disposal must be processed within 21 days.

- The warehouse refusal, or denial rate, at time of pick must be below 0.80% (inventory record indicates material on-hand but none found in location(s) at time of pick).

Additional customer service performance indicators used by DDDC include Shipping Accuracy, Inventory Accuracy, Storage Density, and Safety. These are monitored daily and posted throughout the facility so employees are aware of the required standard and the performance achieved. DDDC also reports customer service performance indicators to DDC daily.

Customer service performance indicators used by benchmark firms include:

- Dock-to-Stock Time,
- Shipping Accuracy (Perfect Order Percentage),
- Inventory Accuracy,
- Warehouse Order Cycle-Time,
- Storage Density,
- Fill Rate, and
- Safety.

Customer service performance indicators measured by DDDC and our benchmark firms are closely aligned. DDDC and our benchmark firms monitor and report customer service performance indicators daily.

4. Comparison of Measures

Figure 3.2 displays a comparison of performance measures used by DDDC and our benchmarked firms. It highlights the disparity in the use of productivity performance indicators between DDDC and benchmarked firms. Further, it displays the similarity in employment of performance measures among our benchmarked firms. The asterisks in DDDC's column denote special circumstances. For business performance indicators, DDDC's measures of Cost per Issue and Lines per FTE are closely aligned, but not the same as industry's Physical Distribution Costs as a Percentage of Sales and Sales to Full Time Equivalents. Under productivity performance indicators, DDDC's measure of Lines to FTE is again similar to commercial industry's Annual Lines Shipped to Annual Labor Hours Expended. Under customer service performance indicators, DDDC can approximate Shipping Accuracy using the number of Reports of Discrepancy it receives from customers in relation to the number of issues made. However, the Shipping Accuracy measure is not calculated and used by management regularly.

C. METHODS OF OBTAINING MEASUREMENT DATA

1. Obtaining Measurement Data at DDDC

There are three information technology systems employed in the management of DDDC: the Distribution Standards System (DSS), the Management Information System (MIS), and the Automated Time, Attendance and Productive System (ATAAPS).

	Measures	Company			
		DDDC	A	C	E
Business Performance Indicators	Inventory Turnover		X	X	X
	Sales to Inventory Ratio		X	X	X
	Physical Distribution Costs as Percentage of Sales	*	X	X	X
	Sales to Full Time Equivalents	*	X	X	X
Productivity Performance Indicators	Lines Received Per Hour Per Person		X	X	X
	Lines Stowed Per Hour Per Person		X	X	X
	Lines Picked Per Hour Per Person		X	X	X
	Number of Packs Per Hour Per Person	X	X	X	X
	Number of Shipment Manifests Per Day Per Person		X	X	X
	Annual Lines Shipped to Annual Labor Hours Expended	*	X	X	X
	Annual Lines Inventoried to Inventory Personnel Hours Expended		X	X	X
Customer Service Performance Indicators	Dock-to-Stock Time	X	X	X	X
	Shipping Accuracy	*	X	X	X
	Inventory Accuracy	X	X	X	X
	Warehouse Order Cycle Time	X	X	X	X
	Storage Density	X	X	X	X
	Fill Rate	X	X	X	X
	Safety	X	X	X	X

Figure 3.2. Comparison of Performance Measures

a. Distribution Standard System (DSS)

DSS is the warehouse management system used throughout DLA's 22 depots. DSS is the entry point of customer orders to the depot. It tracks the status of each customer order from receipt to shipment, building necessary records and documents for use by all functional areas of DDDC. All DDDC personnel working in core functions interface with DSS through handheld RF scanners and keyboard input. The data necessary to calculate productivity performance is captured as employees interface with DSS. However, DSS is not used to provide reports to DDDC management regarding productivity performance.

DSS does provide supervisors the ability to schedule workload flow to specific sections of the warehouse. It provides supervisors with real-time updates of the amount of orders remaining within their workcenters and the current progress in completing those orders.

b. Management Information System (MIS)

MIS interacts with DSS to extract and present data relating to business and customer service performance indicators. MIS receives order information at receipt, label, and shipment timeframes, but does not calculate performance indicators until the item is considered shipped; thus it is not useful in monitoring real-time performance. MIS does not capture personnel assigned to a function and the hours attributed to each function, so productivity calculations are not possible.

MIS information is used by depot support personnel to calculate and report business and customer service performance figures. Supervisors and leaders do not use MIS in managing core functions and are only familiar with its output. DDC has access to MIS information and uses this to evaluate the relative performance of all depots with respect to business and customer service indicators. [Ref. 13]

c. Automated Time, Attendance and Productive System (ATAAPS)

ATAAPS is the payroll system used by depots. It assigns labor hours against 80 cost account codes aligned to specific functions within the depot. The receipt of bulk material is an example of one cost account function. Supervisors are required to manually track and assign the labor time of each of their employees to one of the 80 cost account codes. Business volume from MIS combined with labor hours expended in ATAAPS is used to develop the Labor and Personnel Efficiency Reporting System (LAPERS) report. LAPERS is the only report that displays work volume and corresponding labor expended. [Ref. 11]

The routine movement of personnel between functions makes the supervisor's job of tracking and assigning personnel hours a nightmare. Supervisors have no incentive and little time to undertake the monumental effort required to track each and every employee's movement through the warehouse. Understandably, supervisors assign employees' time to one or two primary cost account codes, thus undermining the ability of DDDC to compute individual productivity.

2. Obtaining Measurement Data at Benchmark Firms

It is interesting that our chosen benchmark firms developed their WMS's in-house, rather than turning to a WMS vendor, considering the number of systems available free of development costs. Because warehousing is a key to their competitiveness, the benchmark firms considered a custom WMS critical to their success.

Benchmark firms' WMSs capture all data relating to nearly every aspect of their physical distribution operation, including labor hours. The WMS acts as the production employees' timekeeper. Employees log into the system at the start of their shifts and the WMS tracks the employees' functions throughout the day, capturing their output and associated labor hours expended. All data necessary to calculate productivity has been captured and the WMS, through utilities, provides the data to managers in a timely and user friendly fashion.

Non-automated methods of data gathering continue to be relied upon by some firms. For example, functions such as packing, which may not use hand-held RF scanning technology, must be measured by some other method. The predominant method for gathering productivity data for these functions is the use of simple tick sheets or counting of customer pick tickets. This method, though simple, is effective in measuring performance at the employee level without placing an extraordinary burden on the supervisors tabulating the data.

D. HOW MEASUREMENT DATA IS USED IN MANAGEMENT

1. Management Use of Measures at DDDC

DDDC's two business performance indicators - Lines to FTE and Cost Per Line - are measured and reported to DDC. These measures provide minimal value to DDDC management because they have little control over the factors comprising the measure.

For example, in the calculation of Lines to FTE, DDDC has no control over the number of lines it processes in a reporting period. Lines processed depend upon customer requests directed to DDDC and inventory location decisions made by the individual services. DDDC has minimal control over the number of FTEs it employs, because the number of FTEs is set by DDC at the beginning of the Fiscal Year. It is based upon anticipated business volume, and DDDC has no authority to adjust staffing levels. DDDC has no control over the numerator and little control over the denominator, thus the measure ultimately indicates DDC's rather than DDDC's business performance.

We previously highlighted DDDC's lack of performance indicators that measure productivity. Packing is the only division where DDDC employs productivity measurement in management. Employee productivity data gathered by the Packing division supervisor is used in formally evaluating employee performance.

LAPERS is the only report capturing both labor hours and business volume to calculate productivity. However, management does not use the divisional labor efficiency calculations in LAPERS. LAPERS functional standards are no longer

accurate, and supervisors cannot reasonably track and assign labor hours to the more than 80 cost account codes.

DDDC makes effective use of customer service performance indicators to monitor trends in performance. Performance data is gathered daily and posted so that all employees are aware of depot standing relative to performance goals. Managers use daily reports on customer service measures to determine functions requiring additional personnel resources. Additional personnel may be assigned to different functional areas or overtime may be authorized to ensure conformance with customer service standards. This action, adding additional resources to correct for poor performance, can be expected when managing to high level metrics rather than individual performance metrics. It is reasonable to suspect that high level metrics are less effective than individual performance metrics in motivating employee's productivity. With high level metrics, the individual presumably feels less responsible for poor performance than if the poor performance can be directly attributed to him with an individual metric.

2. Management Use of Measures at Benchmark Firms

The three general categories of key performance indicators (business, productivity, and quality) are heavily relied upon in management of the organizations we benchmarked. For example, benchmarked firms used business and productivity performance indicators to assist them in making warehouse investment decisions. Commercial firms were able to calculate the payback period for mechanized equipment using forecast business volume and the difference between current productivity and

anticipated productivity after installation of new equipment. Firms we interviewed would not make purchases if the payback period exceeded five years.

Another use of performance indicators includes identifying problems early through trend analysis, ensuring proactive problem resolution. More than one firm we interviewed identified the correlation between employee turnover and declining productivity. One firm resolved the issue by using professional recruiters to screen applicants with the goal of obtaining higher quality employees. Their actions reduced the employee turnover rate and reversed the trend in declining productivity.

Determining the required workforce to process the forecasted workload and the timeframe required by the available workforce to complete tasking is another example of effective use of performance measurement. One firm interviewed used forecasting to closely match employee levels to anticipated workload. Their forecasts and productivity measures were accurate enough to allow them to meet their union's requirement of seven days notice for any changes in workforce level. With accurate productivity measures, the firm was able to closely match the required workforce to the projected workload, eliminating employee idle time and reducing costs.

We observed many examples of the use of performance measures for employee and team evaluation. One firm negotiated an innovative pay and performance plan with their employees that is tied directly to team productivity. Engineered or historical performance baselines for the team were established, and teams are evaluated on their performance over a 26-week period. When team productivity exceeds the baseline, the

employees and the company share a reward pool. Employees receive 2/3 of the reward and the company receives 1/3. Conversely, if team productivity falls below the baseline, employees and the company share a "cost" pool. Employees absorb 1/3 of the "cost" while the company absorbs 2/3. Both employees and the company have an incentive to improve productivity and both suffer negative consequences if productivity fails to meet baseline standards.

E. DIFFERENCES IN MEASURES, METHODS, AND USES OF PERFORMANCE DATA

The differences in the measures, methods, and uses of performance measures between DDDC and our benchmarked firms stem from the degree of competition they face in their business environment.

DDDC had little need for comprehensive performance measures prior to DLA initiating A-76 competition. As management information systems developed, they did not incorporate methods to measure productivity because there was no need.

In contrast, our benchmark firms have operated in increasingly competitive environments for decades. The competitive nature of their industry requires management attention on all facets of their operations. Continuous improvement in their distribution processes is seen as absolutely essential to remaining a viable competitor in the marketplace.

1. Differences in Performance Measures

DDDC's measures are focused almost solely on customer service. The lack of cost competition in DOD contributes to this narrow focus. DDDC's measures are designed to ensure that they are meeting the customers' expectations and the standards set by DDC. Activities in the DOD business environment put little emphasis on minimizing resources required to accomplish their mission, until recently. DDDC could take action to ensure their customer service goals were met with little concern over the resources required to do so.

Contrast DDDC's performance measures with those of our benchmark firms. The benchmark firms have developed comprehensive measures that provide them a well-rounded view of their performance and the ability to focus on every aspect of their operation. One interviewed manager stated, "Any function that we can measure, we will metric". [Ref. 14] This does not obviate the need for the measure to be meaningful, but it does highlight the drive by commercial firms to monitor every aspect of their operation with the aim of gaining insight into their processes and identifying opportunities for improvement.

2. Differences in the Methods of Gathering Performance Measures

DDDC employs three information systems to manage its physical distribution functions: DSS, MIS, ATAAPS. These systems combine, gather and provide the performance data required by DDDC to meet DDC's customer service standards. The three systems do not provide the same level of support as the systems utilized by

commercial firms. The need to measure all aspects of a distribution depot's performance requires a robust WMS.

3. Differences in the Use of Performance Measures

The most striking difference in the management application of performance indicators is DDDC's singular focus on customer service indicators versus benchmark firms comprehensive use of performance indicators. Focusing on customer service measures, and to a lesser extent business measures, and ignoring productivity prevents them from determining the most efficient workforce required to meet the standards set by DDC. They have no baseline for evaluating their employees for the purpose of promotion or pay increases. They have no baseline for developing or operating an incentive plan that would motivate employees to achieve increased efficiency.

Benchmarked firms were acutely sensitive to their customer service performance indicators. However, they did not focus on customer service to the detriment of any other function. Productivity measures are important to them because their level of productivity relates to their competitive position in industry. Productivity measures are a yardstick by which management and employees are evaluated, and productivity measures are necessary for their employee incentive systems. Business performance indicators tie productivity and customer service measures together and relate the distribution centers performance to the bottom line.

IV. PERFORMANCE COMPARISON AND GAP ANALYSIS

We compared the performance levels of DDDC and benchmark firms to attempt to quantify the performance gap. Because DDDC does not measure productivity of most core processes, we derived their performance figures using aggregate data gathered from DDDC. We compare the derived figures, along with existing DDDC performance metrics to our benchmark firms to quantify the performance gap. We follow with our analysis of qualitative factors contributing to the performance gap.

A. DERIVING PERFORMANCE FIGURES FOR DDDC

We derived performance figures for the core warehouse functions. Due to the lack of productivity measures at DDDC, we calculated the performance level by using gross production figures. Annual volume for a particular function and average number of employees assigned to that function during the year were used to calculate gross productivity ratios. We were limited to the data gathered by DDDC in measuring their customer service indicators. Minimal data was available to support productivity calculations to the individual or team level.

We used the following constants commonly used by our benchmarked firms throughout our calculations: [Refs. 15, 16, and 17]

- 250 annual productive workdays per employee.
- 6.75 hours of productive labor per person per day.
- Only those personnel directly assigned to production functions were utilized in calculations. Personnel assigned to maintenance, inventory integrity, and other depot support functions were not considered in our calculations.

1. Receiving

We included transshipped material (DTO) with the total receipt calculation. DDDC does not consider DTO material a receipt, but rather calculates it as an issue. Because DTO material is handled by receiving, we included DTO material in our calculation. Excluding DTO material would unfairly impact the productivity calculation.

Receiving productivity is calculated as follows:

$$\frac{\text{TOTAL RECEIPTS}}{\text{TOTAL MAN HOURS EXPENDED}} =$$

$$\frac{589{,}787 \text{ Total Receipts for the Year}}{50 \text{ Employees} \times 250 \text{ Workdays/Year} \times 6.75 \text{ Hours/Day}} = 6.99 \text{ Receipts/Hour/Person.}$$

2. Storage and Issue

Benchmark companies calculate productivity for both storage and issue functions separately. DDDC does not have the capability to differentiate the labor hours dedicated to these functions. A given labor hour for an employee assigned to storage may include storage, issue, and inventory of material. No distinction is made between storage and issue functions. Therefore, we calculate a combined productivity rate for the storage and issue functions.

Storage and issue productivity is calculated as follows:

$$\frac{\text{TOTAL STORAGE AND ISSUE TRANSACTIONS}}{\text{TOTAL MAN HOURS EXPENDED}} =$$

$$\frac{920{,}717 \text{ Transactions per Year}}{67 \text{ Employees} \times 250 \text{ Days/Year} \times 6.75 \text{ Hours/Day}} = 8.14 \text{ Stows and Issues/Hour}$$

3. Pack and Ship

Pack and ship productivity is:

$$\frac{\text{TOTAL ITEMS REQUIRING PACKING}}{\text{TOTAL MANHOURS EXPENDED}} =$$

$$\frac{849{,}473 \text{ Items Requiring Packing per Year}}{82 \text{ Employees} \times 250 \text{ Days/Year} \times 6.75 \text{ Hours/Day}} = 6.13 \text{ Packs Per Person Per Hour}$$

B. COMPARISON OF DDDC PERFORMANCE LEVEL AND BENCHMARK STANDARDS

Figure 4.1 shows the derived DDDC performance figures compared with those of our benchmark firms. An X entry indicates the metric is measured but the benchmark firm did not provide the data. An N/M entry indicates the metric is not measured.

Physical Distribution Costs as a Percentage of Sales is measured but not provided by our benchmark firms. DDDC's related measure of Cost per Line is provided. Similarly, Sales to Full Time Equivalents for our commercial firms relates closely to DDDC's Lines to FTE. DDDC's figures are highlighted with an asterisk to indicate the difference.

Productivity Performance Indicators suggest a significant disparity between performance levels at DDDC and our benchmark firms. We address contributing factors to the performance gap in later analysis. Several figures from our benchmark firms may catch the reader's attention and require explanation. Note that Lines Received Per Hour Per Person for Firm C is significantly greater than for other benchmark firms are. Company C uses a third party packager and mechanization to achieve high productivity. The third party packager places the firm's material in tote pans and bins so that when received at Company C's dock, items are placed directly on a conveyor to their storage location without the need to stage material and pull documentation.

Annual Lines Shipped to Annual Labor Hours Expended for Firm A is significantly higher than are the other benchmark firms. Company A achieved significant productivity across all functional lines allowing them to ship 8.6 million lines annually to customers with 240 total production employees. Contrast their performance with Company C shipping 10.7 million lines annually with 750 total production employees.

There are two ways to analyze the performance gap: quantitatively, by establishing the difference in performance measures, and qualitatively, by describing the factors contributing to the performance gap, such as the use of third party packagers to ensure uniformity of receipts.

	Measures	Company			
		DDDC	A	C	E
Business Performance Indicators	Inventory Turnover	N/M	2.8/year	X	1.0/year
	Sales to Inventory Ratio	N/M	2.5	X	1.4
	Physical Distribution Costs as Percentage of Sales	* $25.60 *	X	X	X
	Sales to Full Time Equivalents	* 2,560.3 *	$2.8M	X	$4.4M
Productivity Performance Indicators	Lines Received Per Hour Per Person	7	35	56	27
	Lines Stowed Per Hour Per Person	8	33	26	18
	Lines Picked Per Hour Per Person		21	20	19
	Number of Packs Per Hour Per Person	6	21	16	17
	Number of Shipment Manifests Per Day Per Person	4	18	20	13
	Annual Lines Shipped to Annual Labor Hours Expended	2	21	9	6
	Annual Lines Inventoried to Inventory Personnel Hours Expended	5	38	46	59
Customer Service Performance Indicators	Dock-to-Stock Time	20.8hrs.	15.5hrs.	16.2hrs.	21.3 hrs.
	Shipping Accuracy	99.57%	99.7%	99.2%	98.69%
	Inventory Accuracy	96.7%	99.3%	99.1%	98.6%
	Warehouse Order Cycle Time	20.34 hrs.	8 hrs. Priority 36 hrs. Routine	24 hrs.	2 hrs. Priority 24 hrs. Routine
	Storage Density	85%	100%	94%	92%
	Fill Rate	N/M	98.4%	94.1%	94%
	Safety	0.05%	0.03%	0.009%	0.012%

Figure 4.1. Comparison of Performance Data

There is natural tendency to stress quantitative measures before the qualitative factors. Managers who have been provided incentives through objectives, targets, and other quantitative goals have a natural predisposition to want to know what the target number is. They want to know the metric, whether unit cost, level of customer satisfaction, or asset turns, and the effect on profit and loss. We believe that concentrating on the metric and excluding analysis of the underlying process is shortsighted. The qualitative explains why the metric is what it is. Ultimately, the gap must be quantified and expressed in terms that show the effect on the operation. The qualitative should precede the quantitative since one is a result of the other and not the reverse. [Ref. 6:pp. 128-129]

In the process of gathering benchmark data, we sought to gain an understanding of the practices behind the corresponding performance measure. Understanding the process gave meaning to the measures and is the baseline for the qualitative analysis of the performance gap.

C. ANALYSIS OF THE PERFORMANCE GAP

Factors contributing to the performance gap may be grouped into three categories identified by Camp: process practices, business practices, and operational structure. A brief description of each category follows:

- Process practices: The most obvious practices are those practices and methods that make up the processes themselves. The objective is to describe the business process and associated methods and practices that make the process efficient.

- Business practices: Business practices apply across the process and generally determine methods for handling resources applied to the process. They are usually operational in nature, employment related, or management practice related. They include management of exceptions to the process, job structuring, employment practices including use of part time positions and skill level hired, and management practices such as incentives used, performance measurement systems selected, and organization structure that are common across the process.

- Operational structure: Operational structure is not a practice in and of itself. Two considerations are of interest, geographic locations of facilities, and operations located at a site. Whether facilities are centralized or decentralized to be near or far from customers is one consideration. Whether complimentary operations are collocated at one site is another structural consideration. [Ref. 6:pp. 142-143]

The following qualitative factors contributed to the performance gap between DDDC and our benchmarked firms:

1. Process Practices

Most often what separates world class performers from DDDC are their practices. The performance measures are merely an indicator of the design and management of the underlying warehouse processes. Frazelle states:

> We often look for excuses such as a lack of resources, the burden of the union, the attitude of the executives, etc. The truth is in the processes, policies, and procedures that are carried out inside the four walls of the warehouse. [Ref. 10:p. 108]

We will use Frazelle's warehouse practices gap analysis to evaluate the warehousing practices of DDDC. The analysis employs practice descriptions that are not quantifiable. Instead, each functional area (receiving, putaway, storage, order picking, shipping, communications, and work measurement) is described on a scale with the best

being world-class (stage 5), the middle being middle-class (stage 3), and the lowest being no-class (stage 1) practices. Figure 4.2 provides warehousing practice descriptions and ratings. The rating is computed by assigning the score associated with the stage (i.e., Stage 2 equals a score of 2). When multiple stages are applicable, the score is computed by averaging. Assigned ratings for DDDC are included in the last column. A graphical representation of the warehouse practices gap analysis is presented as Figure 4.3. Each of the radials represents one of the functional areas listed in Figure 4.2. The outer ring defines world class standards. DDDC's warehousing practices are plotted relative to the world class standards, along with the warehouse practices of benchmarked firms. Benchmark firms calculations for assigned ratings can be found in Appendix B.

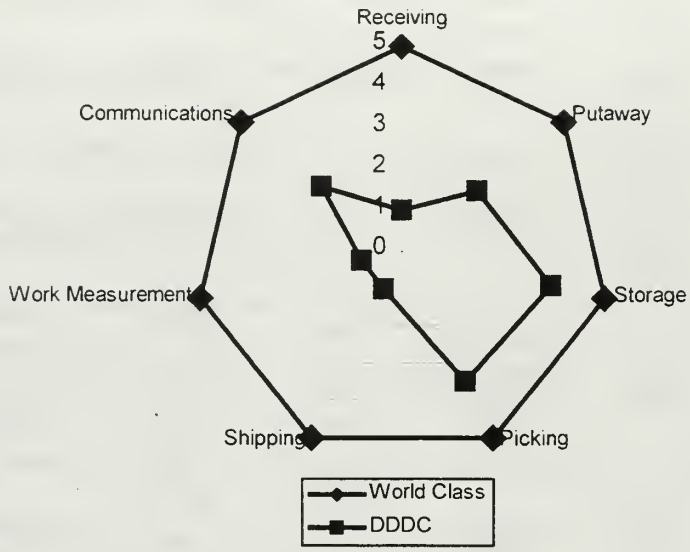
The following process practices contributed to the performance gap:

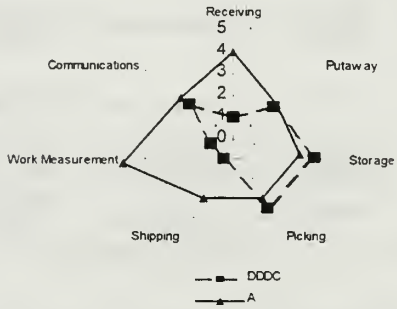
a. Troubleshooting.

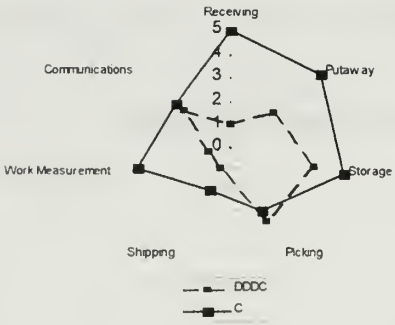
There are approximately 430 personnel working at DDDC. Ninety personnel are assigned to depot support, leaving 340 personnel assigned to the production function. However, a significant portion of production personnel time is dedicated to what can best be described as troubleshooting. Because of pervasive process problems within DOD, core processes do not function as smoothly as their commercial counterparts.

Functional Area	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Rating
Receiving	Unload, Stage, & Check In	Immediate Putaway to Reserve	Immediate Putaway to Primary	Cross-Docking	Pre-Receiving	**1**
Putaway	First-Come-First-Served	Batched by Zone	Batched and Sequenced	Location to Stocker	Automated Putaway	**2.3**
Storage	Floor Storage	Conventional Racks & Bins	Some Double Deep Storage	Some Narrow Aisle Storage	Optimal Hybrid Storage	**3.7**
Picking	Pick to Single Order	Batch Picking	Zone Picking with Progressive Assembly	Zone Picking with Downstream Sorting	Dynamic Picking	**3.5**
Shipping	Check, Stage, & Load	Stage & Load	Direct Load	Automated Loading	Pick-to-Trailer	**1**
Work Measurement	No Standards	Standards Used for Planning	Standards Used for Evaluation	Standards Used for Incentive Pay	Standards Used for Continuous Feedback	**1**
Communications	Paper	Bar Code Scanning	RF Terminals	Hands Free	Virtual Displays	**2.5**

Figure 4.2. Warehouse Practices Description and Ratings







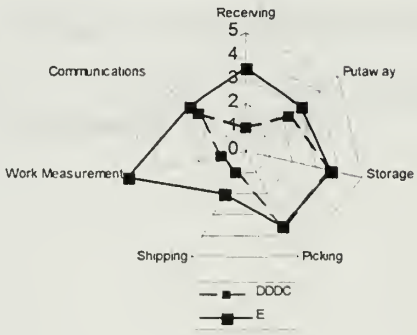


Figure 4.3. Gap Analysis

For example, DDDC stocks approximately 460,000 line items, a total comparable to the benchmarked firms. Benchmarked firms can reasonably expect any one of the 400,000 line items they stock to show up at the receiving door on any given day (of course, many use advanced receiving procedures so they know exactly what is going to arrive up and when it will arrive). DDDC on the other hand, stocking 460,000 line items, may receive any one of more than 4,000,000 line items managed by DLA at the receiving dock. A receipt that is not stocked becomes a minor problem. The problems in receiving continue to grow considering the quantity of material which is improperly labeled, or worse, not labeled at all. These are pervasive problems throughout DOD physical distribution facilities that the commercial sector does not deal with because they have corrected the underlying causes.

An example demonstrates the magnitude of the troubleshooting problem at DDDC. The Storage Division supervisor at North Island tracks the labor hours of his 44 employees, categorizing them into one of 6 functions, 5 of them being productive and 1 miscellaneous. Out of 344 total work hours available to him each day, 150 hours are spent on miscellaneous work. Forty-three percent of production employee time is spent on non-productive (non-core production) processes. [Ref. 18] We found similar though less glaring examples throughout the depot.

b. Material Receipt.

DDDC classifies material into one of six categories when material is received. Each of these classifications require different procedures for processing. The

result is added delay as additional time is spent sorting material and staging it for movement to the next process. In contrast, benchmarked firms classify material into two or three categories at most. Fewer categories reduce the time spent sorting and staging. The end result is faster dock-to-stock time.

c. Third Party Packagers

Material arriving at DDDC's receiving dock is frequently mislabeled or not labeled at all. This starts the troubleshooting sequence described previously. Two of our benchmarked firms employed third party packagers to eliminate this problem. The use of third party packagers ensured that receipts were packaged and identified in strict accordance with the firm's requirements. The third party packagers were provided with the firm's mechanized material handling equipment (tote pans, bins, and slave pallets). When material was received at the dock, receipt uniformity, identification, and packaging enabled companies to reduce dock-to-stock time significantly.

Additional benefits include less damage to material and increased storage density rates. The quality and uniformity of the packaging also facilitates pulling of material to fill customer orders and packaging material for shipment.

d. Advanced Receiving

When DDDC receives material, it has no advanced notice of its arrival. Since receiving personnel are not aware of impending arrivals, a crew to unload the material is not immediately available. When a crew becomes available, the material is

unloaded and staged on the dock. Paperwork is pulled and the receipt is sorted and staged for movement to the next process.

Contrast this with the use of advance receiving (pre-receiving) in one of our benchmarked firms. Material for stock is received by a third party packager. The third party packager ensures material is properly marked and packaged in accordance with the firm's guidelines. Material is loaded into the benchmarked firm's tote pans or full pallet bins and identified by bar code label. Full trailer loads are brought to the benchmarked firm's receiving dock, after pre-arrival notification. A crew to unload the material is available when the truck arrives because of the notification. The material is immediately unloaded and moved to its storage location by conveyor, guided by the barcode placed on the tote pan or pallet by the third party packager.

The amount of material handling and elapsed time in DDDC's process is much greater than that at the benchmarked firm. Receiving employee productivity at the benchmarked firm is significantly higher. Employees are able to receive 56 lines per hour as compared to DDDC's estimated 7 per hour.

2. Business Practices

a. Inadequate Management Information Systems

DDDC's current management information systems play a significant role in hampering DDDC's ability to measure productivity. An examination of the three systems (DSS, MIS, ATAAPS), their interaction, and supervisor reliance upon them are

presented to amplify the stark contrast between the problems facing DDDC supervisors and their counterparts at world class operations.

The reliance upon three separate management information systems to manage DDDC operations is cumbersome and counter productive to supervisor's efforts to manage workload and employees. DSS, as the primary WMS employed by DDC distribution depots, has been designed to support requirements unique to each of the three Services. DSS originated from the Army's Area Oriented Depot (AOD) WMS system. DDC incorporated system changes as it absorbed each of the Service's physical distribution points. The attempt to provide a "one size fits all" product has resulted in a powerful, but very complex system. Attempts to change and improve the system through systems change requests (SCR) are slow to be enacted as they require review and approval at three command levels within DDC and its parent command, Defense Logistics Support Command (DLSC). [Ref. 13]

MIS captures business data from DSS that enables DDC to evaluate the performance of its depots. System analysts at DDDC also have the ability to review and extract MIS performance data providing management with the tools necessary to evaluate overall organizational performance in meeting material processing objectives. The MIS system does not capture personnel/labor hour data. Labor hours assigned to specific cost account codes (warehouse functions) are captured only in ATAAPS. [Ref. 11]

The inability of any of these three systems to provide managers with productivity performance measurement, and therefore, productivity management

capabilities, is a detriment to achieving world class performance. Problems with DSS are compounded by an apparent lack of supervisor training on the full capabilities of DSS in scheduling and monitoring workload. Though detailed productivity measures are not available within DSS, batch selector reports within the production, planning, and control report module can provide supervisors with an overview of daily performance within their area of operation (percent of work completed/remaining). Supervisors were generally not aware of this function in DSS and demonstrated limited knowledge of ways in which DSS could be more fully utilized.

ATAAPS assigns more than 80 separate cost account codes to DDDC production functions. Each employee is assigned a "home" cost account code reflecting his primary job assignment. Employees are commonly called upon to move between processes (i.e., from storage to order picking) throughout the day. To properly account for employee movement between functions (referred to as "exceptions"), or between divisions (referred to as "borrowing" or "loaning") places an enormous administrative burden on supervisors. Supervisors have little inclination or incentive to accurately capture this data and update ATAAPS. This has the effect of creating mismatches between MIS business volume and ATAAPS labor hours. In effect, this negates the usefulness of the LAPERS report, the only report dedicated to providing managers with the means to determine the efficiency and performance of their operations.

In contrast, WMSs utilized by our commercial benchmarking firms captured all the data necessary to evaluate performance within the core warehouse

functions. The handheld RF technology and system terminals throughout their warehouses were capturing business activity and labor expended simultaneously. Supervisors were not monitoring employee movement for timekeeping purposes; the WMS did that while at the same time using the same information to capture employee productivity. Throughout the day, a supervisor need only enter an employee's I.D. number to determine the amount of work processed by the employee, the number of productive hours the employee was in the system (lunch breaks and training sessions are automatically deducted as non-productive time), and an overall productivity rate for the employee. This method can also be applied to employee teams to determine team productivity. Our benchmark visits revealed companies using their WMS, employee productivity standards, and forecasted workload to determine the required number of employees to perform upcoming work.

Frazelle suggests that performance measurement improvements, and ultimately productivity cannot approach world class standards until the WMS and other information systems better support core processes. Frazelle puts it succinctly when he writes,

> "It is impossible to achieve world class standards without world class logistics information systems. Trying to achieve world class warehousing without a world class WMS is like trying to win the Indianapolis 500 on a bicycle." [Ref. 10:p. 197]

b. Lack of Incentives to Reward Productivity

DDDC's inability to provide realistic incentives for superior performance contributes to the performance gap. A manager at one of our benchmarked firms highlighted the necessity of employee incentives:

> We achieve high productivity not by establishing a performance standard and ensuring everyone achieves it. We achieve high productivity by setting a challenging standard and relying on those personnel who will exceed the standards to reap the reward balancing those employees who cannot for some reason achieve the standard. [Ref. 19]

One of our benchmarked firms used an incentive system that would fit well in DDDC's environment where monetary awards are not always available. Employees that produce 140% of the output standard with zero errors in the day earn one hour off with pay. An average of 10 to 14 out of 200 employees qualify for the incentive each day.

c. Focus on Customer Service Performance Indicators

DDDC's measurement focus is on customer service performance indicators. Productivity performance indicators are not reliably measured. Focusing on customer service performance metrics and ignoring productivity performance metrics is not a well-balanced approach to effectively managing distribution processes. DDDC is able to achieve the customer service standards set by DDC; however, their inability to reliably measure employee productivity prevents them from determining the most efficient workforce required to complete projected workloads. There is no method for effectively evaluating their employee's contributions to core functions. Further, there is

no method to determine a baseline production figure, which could then be used to develop an incentive plan for employees. In contrast, our benchmarked firms used comprehensive performance measures that allow them to focus on nearly every aspect of their operation with the aim of gaining insight into their processes and identifying opportunities for improvement.

3. Operational Structure

a. Physical Layout Inefficiencies

Another substantial contributor to the performance gap are physical layout inefficiencies at DDDC. A common denominator among benchmarked firms, regardless of the number of line items stocked or volume of business, was the use of purpose built facilities placing all of the physical distribution functions under one roof. A second important and closely related aspect is the ability (preplanned) to expand the facility if additional volume makes it necessary. By contrast, DDDC operations span 27 separate warehouse facilities to house stock levels that benchmark firms are able to warehouse under one roof. Exacerbating the problem at DDDC is the distance between facilities. The storage complex at the Naval Station is separated from the storage complex at North Island by 7 miles. Travel time between the two is approximately 15 minutes when traffic is light. It can be up to 45 minutes when traffic is heavy.

The physical separation of facilities has forced DDDC to make efficiency choices. For example, four geographically separate packing functions are located at DDDC,

whereas benchmarked firms maintained one, or at most two packing functions (light and heavy), both under the same roof.

b. Inefficiencies Associated with Large Storage Facilities

The inefficiencies associated with large storage facilities are closely related to physical layout efficiency. A large facility is required to stock DDDC's 460,000 line items. Our benchmark firms also maintain large warehouse facilities. The theory of economies of scale in warehousing and distribution operations receives little support. The productivity hurdles of excessive travel distances, poor work flow visibility, and difficult communication offset any economies brought on by increased order volumes or high levels of mechanization. [Ref.10:p. 102]

DDDC and benchmark firms use large warehouse facilities. The difference lies in the amount of warehouse excess capacity desired. Benchmark firms sought to maintain storage utilization rates of 95%. DLA's goal for storage utilization is 85%. DDDC can expect greater inefficiency than their commercial counterparts because lower utilization requires additional space to warehouse the same amount of material than would a facility with a higher utilization rate. Larger facilities increase productivity hurdles such as travel distance, poor workflow visibility, and difficult communication. Frazelle provides an example:

> In one two million square foot distribution center the productivity penalties for improper slotting, batching, and sequencing result in an estimated walking budget for the warehouse of over $3 million. [Ref. 10:p. 102]

V. CONCLUSIONS AND RECOMMENDATIONS

A. SUMMARY

DOD has demanded reduced infrastructure and logistics cost savings to fund operational readiness and modernization. DLA is DOD's primary logistics provider and will therefore play a significant role in achieving cost savings. DLA's approach to reducing infrastructure and achieving cost savings is streamlining through competition. DLA's distribution depots will compete against commercial firms to determine which can provide physical distribution services at the lowest cost. The competition will be governed by OMB Circular A-76.

A-76 competition requires DDDC to determine its competitive posture. Performance measures are necessary to compare DDDC's effectiveness to commercial firms. Performance measurement is dependent upon the ability to capture performance data. DDDC's information management systems do not report comprehensive performance measures to management. Specifically, DDDC is unable to measure the productivity of employees in core warehousing functions. DDDC is faced with the following questions:

- what productivity measures are used in competitive industry?
- what methods are used to gather productivity data?
- how are productivity measures used in the management of the organization?
- what is DDDC's competitive posture in relation to competitive industry?

We sought to answer these questions through the benchmarking of industry leaders. Benchmarking provided us with the productivity measures, measurement methods, and management uses in world class distribution firms. By deriving DDDC's productivity figures in core warehouse processes, and comparing them to the productivity figures observed at our benchmark firms, we were able to quantify the performance gap. Our research concluded with a discussion of significant qualitative factors responsible for the performance gap.

B. CONCLUSIONS

The following are specific conclusions drawn from our study:

- DDDC has few effective productivity measures in place.
- DDDC's management information systems do not effectively support productivity measurement.
- DDDC cannot effectively manage productivity without the required measures and methods of gathering productivity data.
- There is a significant performance gap between industry leaders and DDDC.

C. RECOMMENDATIONS

We believe implementation of the following recommendations will improve DDDC's competitive position and provide a solid foundation from which a realistic and competitive MEO can be developed.

We recommend that DDDC implement performance metrics designed to capture productivity within core warehouse functions. The following Productivity Performance Indicators should be measured:

- Lines Received Per Hour Per Person,
- Lines Stowed Per Hour Per Person,
- Lines Picked Per Hour Per Person,
- Number of Packs Per Hour Per Person,
- Number of Shipment Manifests Per Day Per Person,
- Annual Lines Shipped to Annual Labor Hours Expended, and
- Annual Lines Inventoried to Dedicated Inventory Labor Hours Expended.

The method to obtain these measures is the basis of our next recommendation, that DDDC seek to modify existing management information systems, particularly DSS, to gather and present data relating to established performance metrics. DSS should emulate benchmark firm's WMSs by capturing employee hours and associated work output and providing real-time productivity performance rates. In the interim, DDDC should consider the use of manual records to capture productivity data (i.e., tally sheets, pick tickets, and check sheets).

Once performance metrics and the ability to measure performance have been established, we recommend that DDDC develop realistic productivity standards to both assess employee performance and develop a baseline for an employee incentive system. Productivity standards may be developed through time studies or measured historical

performance. Another method employed by several benchmark firms was to set the standard at between 80 to 90 percent of their most productive employee's performance.

Our final recommendation is that DDDC establish a benchmarking partnership with a competitive commercial firm. Supervisors, managers, and employees must develop an understanding of what DDDC does well and what it does not do well. There is no substitute for first hand observation, participation, and the sharing of ideas and information. Benchmarking is a process where this can take place. Industry best practices can be identified and either adopted or modified for implementation at DDDC.

D. SUGGESTED TOPICS FOR FURTHER RESEARCH

Commercial and DOD physical distribution processes are undergoing dynamic change. Supply chain management is receiving increased emphasis in efforts to improve competitiveness. Our research recommendations focus on those topics most likely to pay dividends to DDDC and other Defense Distribution Depots facing A-76 competition.

- Analysis of DSS functions and technical capabilities as compared to WMS's employed by industry leaders and third party warehousing providers.
- Analysis and possible redesign of core warehousing processes at DDDC.
- Analysis of employee incentive systems used in competitive physical distribution operations to identify successful initiatives that may be applied within Defense Distribution Depots.
- Analysis of DDDC's cost per issue versus commercial industry's cost per issue. Warehouse activity based costing is fast becoming a requirement in the commercial physical distribution industry and the potential for operational improvements through improved cost management exists within DOD.

APPENDIX A. DDDC FACILITIES

DDDC utilizes a wide range of facilities in order to receive, stow, and issue the material. Their facilities at Naval Station include both mechanized and non-mechanized storage systems and a dedicated warehouse for storage of hazardous material, while the facilities at North Island are completely non-mechanized.

Mechanized facilities include:

1. Ministacker

Automatic storage and retrieval of fast moving binnable items is accomplished through the use of a mini-load automated storage and retrieval system (AS/RS). Metal storage containers are automatically stowed and retrieved from one of six aisles that are 100 feet long and 40 feet high. There are a total of 24,195 metal trays configured for 188,586 storage locations within the ministacker system and six terminal locations to which the metal storage containers are brought for storage and retrieval by personnel

2. Binnable

Slow moving binnable items are stored in one of 10 aisles, 100 feet long and 40 feet high. Manned Storage and Retrieval Machines (MS/RM) are utilized to stow and retrieve items from this area. A conveyor tote system serves each aisles so that material requiring storage is directed from receipt and induction to the aisle where stowed. Material retrieved from the aisle is forwarded via conveyor and tote to sortation and packing. There are 72,870 bins with 312,110 binnable storage locations.

3. Rackable

Material weighing less than 55 pounds and not exceeding 17,280 cubic inches is stored in the rackable complex. There are 43 rackable storage aisles, each 40 feet high and 100 feet long. Aisles are served by an MS/RM utilized to stow and retrieve items. A conveyor tote system serves each aisle so that material requiring storage is directed from receipt and induction to the aisle where stowed. Material retrieved from the aisle is forwarded via conveyor and tote to sortation and packing. There are 79,855 rackable storage locations.

4. Palletable

There are 10 aisles utilized for pallet storage, they are 40 feet high and 100 feet long. Pallets are placed on "slave pallets" at receipt and induction. They are transported to aisles via Automatically Guided Vehicles (AGVs) where an MS/RM is utilized to stow the pallet in its locations. Picks may be in the form of either retrieval of the full pallet or pieces picked from a pallet and placed on a "slave pallet". In either case, these issues are placed on a pallet conveyor that forwards the pallet to an AGV. Full pallets are routed directly to shipping, piece pallets are forwarded to the carton conveyor system where they are loaded for routing to sortation and packing. There are 6,300 pallet locations within the system.

5. Non-Mechanized

Non-mechanized facilities are comprised of numerous warehouses utilizing rack storage locations on which pallets or tri-walls are used to store various quantities of material. Storage and retrieval is conducted through the use of fork trucks and handheld

radio frequency terminals. Non-mechanized storage is utilized primarily for hazardous and specialized material (confidential, pilferable, Nuclear Water Chemicals, etc.). Non-mechanized storage systems are used exclusively at DDDC's North Island facilities.

APPENDIX B. WAREHOUSE PRACTICES ANALYSIS

Company A

Functional Area	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Rating
Receiving	Unload, Stage, & Check In	Immediate Putaway to Reserve	Immediate Putaway to Primary	Cross-Docking	Pre-Receiving	4
Putaway	First-Come-First-Served	Batched by Zone	Batched and Sequenced	Location to Stocker	Automated Putaway	2.5
Storage	Floor Storage	Conventional Racks & Bins	Some Double Deep Storage	Some Narrow Aisle Storage	Optimal Hybrid Storage	3
Picking	Pick to Single Order	Batch Picking	Zone Picking with Progressive Assembly	Zone Picking with Downstream Sorting	Dynamic Picking	3
Shipping	Check, Stage, & Load	Stage & Load	Direct Load	Automated Loading	Pick-to-Trailer	3
Work Measurement	No Standards	Standards Used for Planning	Standards Used for Evaluation	Standards Used for Incentive Pay	Standards Used for Continuous Feedback	5
Communications	Paper	Bar Code Scanning	RF Terminals	Hands Free	Virtual Displays	3

Company C

Functional Area	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Rating
Receiving	Unload, Stage, & Check In	Immediate Putaway to Reserve	Immediate Putaway to Primary	Cross-Docking	Pre-Receiving	5
Putaway	First-Come-First-Served	Batched by Zone	Batched and Sequenced	Location to Stocker	Automated Putaway	5
Storage	Floor Storage	Conventional Racks & Bins	Some Double Deep Storage	Some Narrow Aisle Storage	Optimal Hybrid Storage	5
Picking	Pick to Single Order	Batch Picking	Zone Picking with Progressive Assembly	Zone Picking with Downstream Sorting	Dynamic Picking	3
Shipping	Check, Stage, & Load	Stage & Load	Direct Load	Automated Loading	Pick-to-Trailer	2
Work Measurement	No Standards	Standards Used for Planning	Standards Used for Evaluation	Standards Used for Incentive Pay	Standards Used for Continuous Feedback	4
Communications	Paper	Bar Code Scanning	RF Terminals	Hands Free	Virtual Displays	3

Company E

Functional Area	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Rating
Receiving	Unload, Stage, & Check In	Immediate Putaway to Reserve	Immediate Putaway to Primary	Cross-Docking	Pre-Receiving	**3.5**
Putaway	First-Come-First-Served	Batched by Zone	Batched and Sequenced	Location to Stocker	Automated Putaway	**3**
Storage	Floor Storage	Conventional Racks & Bins	Some Double Deep Storage	Some Narrow Aisle Storage	Optimal Hybrid Storage	**3.7**
Picking	Pick to Single Order	Batch Picking	Zone Picking with Progressive Assembly	Zone Picking with Downstream Sorting	Dynamic Picking	**3.5**
Shipping	Check, Stage, & Load	Stage & Load	Direct Load	Automated Loading	Pick-to-Trailer	**2**
Work Measurement	No Standards	Standards Used for Planning	Standards Used for Evaluation	Standards Used for Incentive Pay	Standards Used for Continuous Feedback	**5**
Communications	Paper	Bar Code Scanning	RF Terminals	Hands Free	Virtual Displays	**3**

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